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Original Study

Influence of Education and Income on Receipt of Dementia Care in Sweden

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A B S T R A C T

Objective: To explore the dementia diagnostic process and drug prescription for persons with dementia (PWD) with different socioeconomic status (SES).
Design: Register-based cohort study.
Setting and Participants: This study included 74,414 PWD aged ≥65 years from the Swedish Dementia Register (2007–2018). Their data were linked with the Swedish Longitudinal Integrated Database for Health Insurance and Labor Market Studies (2006–2017) to acquire the SES information 1 year before dementia diagnosis.
Methods: Education and income—2 traditional SES indicators—were divided into 5 levels. Outcomes comprised the dementia diagnostic examinations, types of dementia diagnosis, diagnostic unit, and prescription of antidementia drugs. Binary logistic regression was performed to evaluate socioeconomic inequalities.
Results: Compared to PWD with the lowest educational level, PWD with the highest educational level had a higher probability of receiving the basic diagnostic workup [odds ratio (OR) 1.19, 95% confidence interval (CI) 1.10-1.29], clock test (OR 1.12, 95% CI 1.02-1.24) and neuroimaging (OR 1.23, 95% CI 1.09-1.39). Compared with PWD in the lowest income quintile, PWD in the highest income quintile presented a higher chance of receiving the basic diagnostic workup (OR 1.35, 95% CI 1.26-1.46), clock test (OR 1.40, 95% CI 1.28-1.52), blood analysis (OR 1.21, 95% CI 1.06-1.39), Mini-Mental State Examination (OR 1.47, 95% CI 1.26-1.70), and neuroimaging (OR 1.30, 95% CI 1.18-1.44). PWD with higher education or income had a higher likelihood of obtaining a specified dementia diagnosis or being diagnosed at a memory clinic. SES presented no association with prescription of antidementia medication, except for the association between education and the use of memantine.
Conclusions and Implications: Higher education or income was significantly associated with higher chance of receiving dementia diagnostic examinations, a specified dementia diagnosis, being diagnosed at a memory clinic, and using memantine. Socioeconomic inequalities in dementia diagnostic process and prescription of memantine occurred among PWD with different education or income levels.

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Dementia is among the top-ten causes of death and disability in Sweden,[1] and worldwide.[2] Globally, there are approximately 50 million persons with dementia (PWD), with nearly 10 million new cases every year.[2] In Sweden, around 150,000 people are diagnosed with dementia, and there are about 24,000 new cases annually.[3] Ensuring equitable access to preventive, diagnostic and care services for this vulnerable population is considered as an important goal in the World Health Organization global action plan for dementia.[4] Socioeconomic inequalities in health have been shown in previous studies.[5] Lower socioeconomic status (SES) is associated with higher risk of morbidity and mortality,[5–7] and socioeconomic inequalities in health continued even in old age.[6,7] Previous studies showed that low education, occupation, and disposable income were associated with a higher dementia-related mortality risk.[8–11] PWD were less likely to receive formal care if they had low education or low individual income,[12] while PWD with higher education had higher chances of receiving cholinesterase inhibitors or memantine in a previous Swedish study.[13]

The influence of SES on the dementia diagnostic process and prescription of antidementia medication is underinvestigated. People with lower SES reported significantly higher levels of unmet health care needs than people in higher positions.[14–17] Assessing the dementia diagnostic process and medication prescription among different SES levels is important to dementia care. It would both ensure the equal access to health care for PWD and help health care providers and policy makers evaluate the quality of care. Our study aimed to investigate the socioeconomic indicators influencing dementia diagnostic process and prescription of antidementia drugs for PWD. We hypothesized that PWD with higher education and income had better access to dementia diagnosis and treatment.

Methods

Study Design and Setting

This study had a retrospective cohort design and included PWD registered in the Swedish Dementia Register (SveDem) between 2007 and 2018. Established in 2007, SveDem is a nationwide register, and has previously been described.[18,19] Individuals are registered at the time of dementia diagnosis, according to the *International Classification of Diseases, Tenth Revision*, codes, and specific diagnostic criteria are used for certain dementia types.[3,18,19] SveDem includes information at baseline registration and annual follow-ups, regarding demographics, cognition, diagnosis, living situation, and medication, as previously described.[3,18,19] With more than 90,000 PWD and more than 57,000 follow-ups, SveDem is the world's largest dementia registry of its kind.[3]

Data on SES (2006-2017) from the Swedish Longitudinal Integrated Database for Health Insurance and Labor Market Studies (LISA) and comorbidities from the Swedish National Patient Register were linked to SveDem through PWD's identity numbers. LISA's goal is to provide a tool for statistical research on health and labor market.[20] LISA includes information regarding education, employment, income, and occupation of all individuals older than 16 years (15 years old after 2010).[20] The Swedish National Patient Register includes data on hospitalization diagnoses since 1987 and added outpatient care after 2001.[21]

Study Participants

Data of 80,004 PWD registered in SveDem (2007-2018) were linked with LISA (2006-2017) to retrieve socioeconomic information 1 year before dementia diagnosis. We excluded 1552 persons diagnosed before 2007, when SveDem was founded. PWD younger than 65 years were excluded in our study (n = 3739). We assumed that PWD had less fluctuations in income after this age because it is the most common retirement age. PWD who had individual disposable income less than 57,200 Swedish krona per year (about 6046 US dollars, with the Swedish Central Bank exchange rate in 2019[22]) were excluded. The older care allowance is a support for persons who have no or low pensions in Sweden. In 2019, the amount that a person with no income and no housing cost can receive from the older care allowance is up to 57,200 Swedish krona per year.[23] It means that the lowest reasonable individual income is 57,200 Swedish krona per year. After inflating the individual disposable income of each person to the 2019 value, we excluded persons with income less than 57,200 Swedish krona. These people had income lower than this threshold or had negative income. These people are likely to live off capital and their income does not represent their SES. A total of 709 out of 80,004 persons (0.89%) were excluded based on this criterion. Finally, this left 74,414 PWD for analysis.

Exposures

SES indicators, including education and individual disposable income, were the 2 main exposures of this study. The highest attained education level was extracted from LISA.[20] Educational levels included compulsory education <9 years, compulsory education 9 years, upper secondary, university <3 years, and university ≥3 years. Education of immigrants is explored by annual questionnaires.[20] If immigrants participate in any educational activity in Sweden, the new level of education will be recorded and overwrite the older one, via their personal identity number.[20] Individual disposable income was defined as the total income that a person received after paying taxes (including all types of income and allowances).[20] Disposable income of PWD 1 year before dementia diagnosis was inflated into 2019 values with inflation rate from the Swedish Consumer Price Index.[24] The inflated income was then classified into quintiles.

Dementia types, types of diagnostic unit, age at dementia diagnosis, and sex were retrieved from SveDem. Other confounding factors included living alone and Mini-Mental State Examination (MMSE) scores at dementia diagnosis. Comorbidities before dementia were condensed into the Charlson Comorbidity Index, which was calculated based on information from the Swedish National Patient Register.[25] LISA also contributed patients' region of birth.

Outcomes

Outcomes, obtained from SveDem, encompassed variables related to the dementia diagnostic process and medication. A basic diagnostic workup was recommended in the 2010 (revised 2017) guidelines by the Swedish National Board of Health and Welfare[26] and is followed up as a quality indicator in SveDem. It includes the completion of a structured patient history and evaluation of the patients' functional ability, physical and psychological status, an interview with a reliable relative or caregiver, and 4 tests that are followed as quality indicators in SveDem: the clock test, a blood analysis (including calcium, TSH, and either homocysteine or B12 and folate), MMSE, and neuroimaging [computed tomography (CT) or magnetic resonance imaging (MRI) of the brain].[26] Additional dementia diagnostic tests registered in SveDem are neuropsychological assessment, occupational therapy assessment, and physiotherapy assessment. Diagnostic units were classified as primary care or memory clinic. Dementia types were categorized as specified dementia diagnoses (Alzheimer's disease, vascular dementia, mixed dementia, dementia with Lewy bodies, frontotemporal dementia, Parkinson's disease, and other dementia) vs unspecified dementia diagnoses. Prescription of cholinesterase inhibitors (donepezil, galantamine, and rivastigmine) and memantine

were examined in persons with Alzheimer's disease or mixed dementia.

Statistical Analyses

Categorical variables were presented as number of cases and percentages. Pearson chi-square or Fisher exact test was employed to compare attributes among different educational levels or income quintiles. Age was described with mean and standard deviation, using ANOVA to acquire a *P* value. Median, interquartile range, and *P* values from Kruskal-Wallis test were used to present MMSE scores.

Two binary logistic regression models were performed to examine the association between each outcome and independent variables (education or disposable individual income), as well as the robustness of the results. The first model was controlled for age at dementia diagnosis, sex, region of birth, living alone, dementia types (except for diagnosis as outcome), Charlson Comorbidity Index, types of diagnostic unit (except for diagnostic unit as outcome), and MMSE scores [except for the basic diagnostic workup and MMSE (yes/no) as dependent variables]. The second model was fully adjusted with the above covariates and additionally controlled for education (if income was the independent variable) or disposable individual income (if education was the independent variable). Spearman correlation was conducted for education and disposable individual income ($r = 0.36$, $P < .001$). Wald test was applied after the regression models to evaluate whether the association between outcomes, and SES indicators was statistically significant. Odds ratio (OR) and 95% confidence interval (95% CI) were reported.

All statistical tests were 2-tailed, with a *P* value less than 0.05 considered statistically significant. Stata, version 15.1 (StataCorp LLC, College Station, TX), was employed to perform the statistical analyses in this study. Missing data were addressed by excluding cases listwise.

Ethical Considerations

Ethical approval was granted by the Swedish Ethical Review Authority. All patients were informed about the registration in SveDem and their data might be used for quality improvement or research purposes. Patients could refuse to participate or withdraw consent at any time. Patient identity was pseudonymized and blinded to the researchers.

Results

Description of the Research Population

Characteristics of PWD were presented according to different educational levels (Table 1) or income quintiles (Table 2). Mean age at dementia diagnosis was around 80 years, lower in PWD with university education ≥3 years (78.9 ± 6.7) and in the highest income quintile (78.9 ± 7.2). The percentage of female PWD differed significantly in educational levels or income quintiles: decreasing from

Table 1
Demographics Among Different Educational Levels (n = 74,414)

	E1 (n = 29,035)	E2 (n = 5240)	E3 (n = 26,165)	E4 (n = 5240)	E5 (n = 7498)	*P*
Age at dementia, y, mean (SD)	81.7 (6.3)	79.8 (7.2)	79.7 (6.9)	78.9 (6.8)	78.9 (6.7)	<.001
Sex, women, n (%)	17,446 (60.1)	3731 (71.2)	15,067 (57.6)	2994 (57.1)	3883 (51.8)	<.001
Living alone, n (%)	17,057 (58.7)	3077 (58.7)	13,793 (52.7)	2592 (49.5)	3354 (44.7)	<.001
Region of birth, n (%)						
Sweden	26,019 (89.6)	4422 (84.4)	23,082 (88.2)	4699 (89.7)	6728 (89.7)	<.001
The Nordic countries except Sweden	1911 (6.6)	396 (7.6)	1675 (6.4)	236 (4.5)	284 (3.8)	<.001
EU28 except the Nordic countries	510 (1.8)	229 (4.4)	931 (3.6)	178 (3.4)	301 (4.0)	<.001
Europe except EU28 & the Nordic countries	275 (0.9)	67 (1.3)	219 (0.8)	32 (0.6)	37 (0.5)	<.001
Former Soviet Union	43 (0.1)	12 (0.2)	37 (0.1)	11 (0.2)	12 (0.2)	.52
Asia	141 (0.5)	69 (1.3)	85 (0.3)	38 (0.7)	51 (0.7)	<.001
Africa	18 (0.1)	4 (0.1)	28 (0.1)	7 (0.1)	23 (0.3)	<.001
North America	37 (0.1)	13 (0.2)	53 (0.2)	19 (0.4)	41 (0.5)	<.001
South America	80 (0.3)	26 (0.5)	51 (0.2)	20 (0.4)	21 (0.3)	.001
Dementia diagnostic examination, n (%)						
The basic diagnostic workup*	19,611 (67.5)	3939 (75.2)	19,871 (75.9)	4128 (78.8)	6117 (81.6)	<.001
Clock test	23,965 (82.5)	4521 (86.3)	22,764 (87.0)	4649 (88.7)	6755 (90.1)	<.001
Blood analysis	26,611 (91.7)	4896 (93.4)	24,468 (93.5)	4928 (94.0)	7124 (95.0)	<.001
CT-MRI	24,047 (82.8)	4630 (88.4)	23,248 (88.9)	4772 (91.1)	6976 (93.0)	<.001
MMSE	26,896 (92.6)	4933 (94.1)	24,751 (94.6)	4987 (95.2)	7196 (96.0)	<.001
Neuropsychological assessment	2333 (8.0)	868 (16.6)	4563 (17.4)	1234 (23.5)	2313 (30.8)	<.001
Occupational therapy assessment	10,812 (37.2)	2279 (43.5)	11,324 (43.3)	2320 (44.3)	3415 (45.5)	<.001
Physiotherapy assessment	1715 (5.9)	290 (5.5)	1430 (5.5)	273 (5.2)	396 (5.3)	<.001
MMSE score, median (IQR)	20.0 (6.0)	22.0 (7.0)	22.0 (7.0)	23.0 (7.0)	24.0 (6.0)	<.001
Types of diagnostic unit, n (%)						
Primary care	16,759 (57.7)	2147 (41.0)	10,893 (41.6)	1822 (34.8)	2058 (27.4)	<.001
Memory clinic	12,276 (42.3)	3093 (59.0)	15,272 (58.4)	3418 (65.2)	5440 (72.6)	<.001
Diagnosis types, n (%)						
Specified dementia†	20,821 (71.7)	4059 (77.5)	20,589 (78.7)	4277 (81.6)	6292 (83.9)	<.001
Unspecified dementia	8199 (28.2)	1181 (22.5)	5568 (21.3)	960 (18.3)	1201 (16.0)	<.001
Drugs, n (%)						
Cholinesterase inhibitors‡	7311 (55.9)	1626 (60.5)	8334 (61.4)	1850 (63.4)	2741 (63.2)	<.001
Memantine‡	1966 (15.0)	399 (14.8)	2049 (15.1)	432 (14.8)	741 (17.1)	<.001
Antipsychotics	1737 (6.0)	326 (6.2)	1414 (5.4)	264 (5.0)	339 (4.5)	<.001

CT, computed tomography; IQR, interquartile range; MRI, magnetic resonance imaging.
Education levels were divided into 5 categories: E1 = compulsory education (<9 years), E2 = compulsory education (9 years), E3 = upper secondary, E4 = university (<3 years), E5 = university (≥3 years). Missing: 1236 (1.7%).

*The basic diagnostic workup meant whether patients received all basic tests (clock test, blood analysis, MMSE, CT-MRI) or not.

†Specified dementia includes Alzheimer's disease, vascular dementia, mixed dementia, dementia with Lewy bodies, frontotemporal dementia, Parkinson's disease, and other dementia.

‡Only patients with Alzheimer's disease or mixed dementia were analyzed (E1 = 13,080, E2 = 2687, E3 = 13,574, E4 = 2919, E5 = 4335).

Table 2
Demographics Among Different Disposable Individual Income (n = 74,414)

	I1 (n = 14,858)	I2 (n = 14,854)	I3 (n = 14,862)	I4 (n = 14,859)	I5 (n = 14,858)	*P*
Age at dementia, y, mean (SD)	80.8 (6.4)	81.0 (6.7)	81.1 (6.6)	80.2 (6.5)	78.9 (7.2)	<.001
Sex, women, n (%)	12,211 (82.2)	10,184 (68.6)	9240 (62.2)	6529 (43.9)	5692 (38.3)	<.001
Living alone, n (%)	5313 (35.8)	9369 (63.1)	10,211 (68.7)	8392 (56.5)	7227 (48.6)	<.001
Region of birth, n (%)						
Sweden	12,537 (84.4)	12,652 (85.2)	13,037 (87.7)	13,383 (90.1)	13,730 (92.4)	<.001
The Nordic countries except Sweden	1071 (7.2)	1091 (7.3)	921 (6.2)	883 (5.9)	598 (4.0)	<.001
EU28 except the Nordic countries	490 (3.3)	487 (3.3)	482 (3.2)	421 (2.8)	379 (2.6)	<.001
Europe except EU28 and the Nordic countries	294 (2.0)	262 (1.8)	175 (1.2)	75 (0.5)	48 (0.3)	<.001
Former Soviet Union	30 (0.2)	41 (0.3)	35 (0.2)	16 (0.1)	10 (0.1)	<.001
Asia	259 (1.7)	185 (1.2)	111 (0.7)	22 (0.1)	28 (0.2)	<.001
Africa	48 (0.3)	29 (0.2)	23 (0.2)	13 (0.1)	12 (0.1)	<.001
North America	33 (0.2)	32 (0.2)	28 (0.2)	35 (0.2)	41 (0.3)	.61
South America	93 (0.6)	74 (0.5)	48 (0.3)	10 (0.1)	12 (0.1)	<.001
Dementia diagnostic examination, n (%)						
The basic diagnostic workup*	10,079 (67.8)	9991 (67.3)	10,757 (72.4)	11,501 (77.4)	11,955 (80.5)	<.001
Clock test	12,177 (82.0)	12,136 (81.7)	12,680 (85.3)	13,129 (88.4)	13,279 (89.4)	<.001
Blood analysis	13,677 (92.1)	13,619 (91.7)	13,740 (92.5)	13,923 (93.7)	14,090 (94.8)	<.001
CT-MRI	12,416 (83.6)	12,355 (83.2)	12,848 (86.4)	13,336 (89.8)	13,685 (92.1)	<.001
MMSE	13,683 (92.1)	13,607 (91.6)	13,935 (93.8)	14,160 (95.3)	14,228 (95.8)	<.001
Neuropsychological assessment	1388 (9.3)	1487 (10.0)	1817 (12.2)	2666 (17.9)	4083 (27.5)	<.001
Occupational therapy assessment	5359 (36.1)	5575 (37.5)	6194 (41.7)	6683 (45.0)	6828 (46.0)	<.001
Physiotherapy assessment	842 (5.7)	923 (6.2)	808 (5.4)	767 (5.2)	822 (5.5)	<.001
MMSE score, median (IQR)	21.0 (7.0)	21.0 (7.0)	21.0 (7.0)	22.0 (7.0)	23.0 (6.0)	<.001
Types of diagnostic unit, n (%)						
Primary care	8045 (54.1)	7915 (53.3)	7476 (50.3)	6129 (41.2)	4494 (30.2)	<.001
Memory clinic	6813 (45.9)	6939 (46.7)	7386 (49.7)	8730 (58.8)	10,364 (69.8)	<.001
Diagnosis types, n (%)						
Specified dementia†	10,752 (72.4)	10,705 (72.1)	11,166 (75.1)	11,841 (79.7)	12,411 (83.5)	<.001
Unspecified dementia	4101 (27.6)	4144 (27.9)	3684 (24.8)	3016 (20.3)	2440 (16.4)	<.001
Drugs, n (%)						
Cholinesterase inhibitors‡	4287 (60.1)	3973 (57.7)	4067 (57.6)	4542 (59.0)	5252 (62.8)	<.001
Memantine‡	1052 (14.7)	1006 (14.6)	1029 (14.6)	1244 (16.2)	1358 (16.2)	<.001
Antipsychotics	926 (6.2)	1005 (6.8)	892 (6.0)	724 (4.9)	637 (4.3)	<.001

CT, computed tomography; IQR, interquartile range; MRI, magnetic resonance imaging.
Disposable individual incomes (in 100SEK), which were ordered from lowest to highest, were divided into quintiles: I1 to I5. Missing: 123 (0.2%).
*The basic diagnostic workup meant whether patients received all basic tests (clock test, blood analysis, MMSE, CT-MRI) or not.
†Specified dementia includes Alzheimer's disease, vascular dementia, mixed dementia, dementia with Lewy bodies, frontotemporal dementia, Parkinson's disease, and other dementia.
‡Only patients with Alzheimer's disease or mixed dementia were analyzed (I1 = 7138, I2 = 6882, I3 = 7059, I4 = 7696, I5 = 8357).

82.2% to 38.3% (corresponding to lowest-to highest-income quintiles). In all education or income groups, more than 90% of PWD were born in Sweden or the other Nordic countries.

Regarding diagnostic process, there was a significant difference in receiving the basic diagnostic workup among educational levels or income quintiles: increasing from 67.5% to 81.6% (from lowest to highest educational levels) and from 67.8% to 80.5% (from lowest to highest income quintiles). The proportions of PWD receiving individual tests separately also increased with education or income. PWD with higher SES were more often diagnosed at memory clinics: 72.6% in PWD with university education ≥3 years vs 42.3% in PWD with only compulsory education <9 years; 69.8% in PWD with highest income quintile vs 45.9% PWD with lowest income quintiles. Unspecified dementia diagnoses were more common among PWD with lower SES.

As for antidementia medications, the proportion of patients with Alzheimer's disease and mixed dementia receiving cholinesterase inhibitors among educational levels or income quintiles differed significantly: 63.2% of PWD with university ≥3 years vs 55.9% in PWD with compulsory education <9 years; 62.8% in PWD with higher income quintile vs 60.1% in PWD with lowest income quintile. A higher proportion of memantine users was also observed among individuals with higher SES.

Dementia Diagnosis and Medication in Association With Education

As shown in Figure 1, PWD with higher education presented significantly higher odds of receiving diagnostic examinations, even when adjusting for level of income: university ≥3 years vs compulsory education <9 years regarding the basic diagnostic workup (OR 1.19, 95% CI 1.10-1.29) or computed tomography and magnetic resonance imaging (OR 1.23, 95% CI 1.09-1.39). Meanwhile, no significant association between receiving blood analysis or MMSE and education was seen when controlling for income. The odds of obtaining a diagnosis in memory clinic for PWD with the highest educational level was more than 2 times higher (OR 2.16, 95% CI 2.02-2.31) than that for PWD with the lowest educational level. Significantly higher odds of receiving specified dementia diagnosis were found in PWD with higher educational levels; however, this was not significant when adjusting for their income. There was no significant association between education and prescription of cholinesterase inhibitors. Compared with PWD with compulsory education <9 years, PWD with university ≥3 years presented higher odds of receiving memantine (OR 1.16, 95% CI 1.04-1.29).

Dementia Diagnosis and Medication in Association With Disposable Individual Income

Disposable individual income was significantly associated with receiving all dementia diagnostic examinations when both adjusting for and not adjusting for education, as shown in Figure 2. Compared with PWD in the lowest income quintile, PWD in the highest quintile presented higher odds of receiving the basic diagnostic workup (OR 1.35, 95% CI 1.26-1.46) and most individual tests. The odds of receiving a diagnosis at a memory clinic for PWD in the highest income quintile

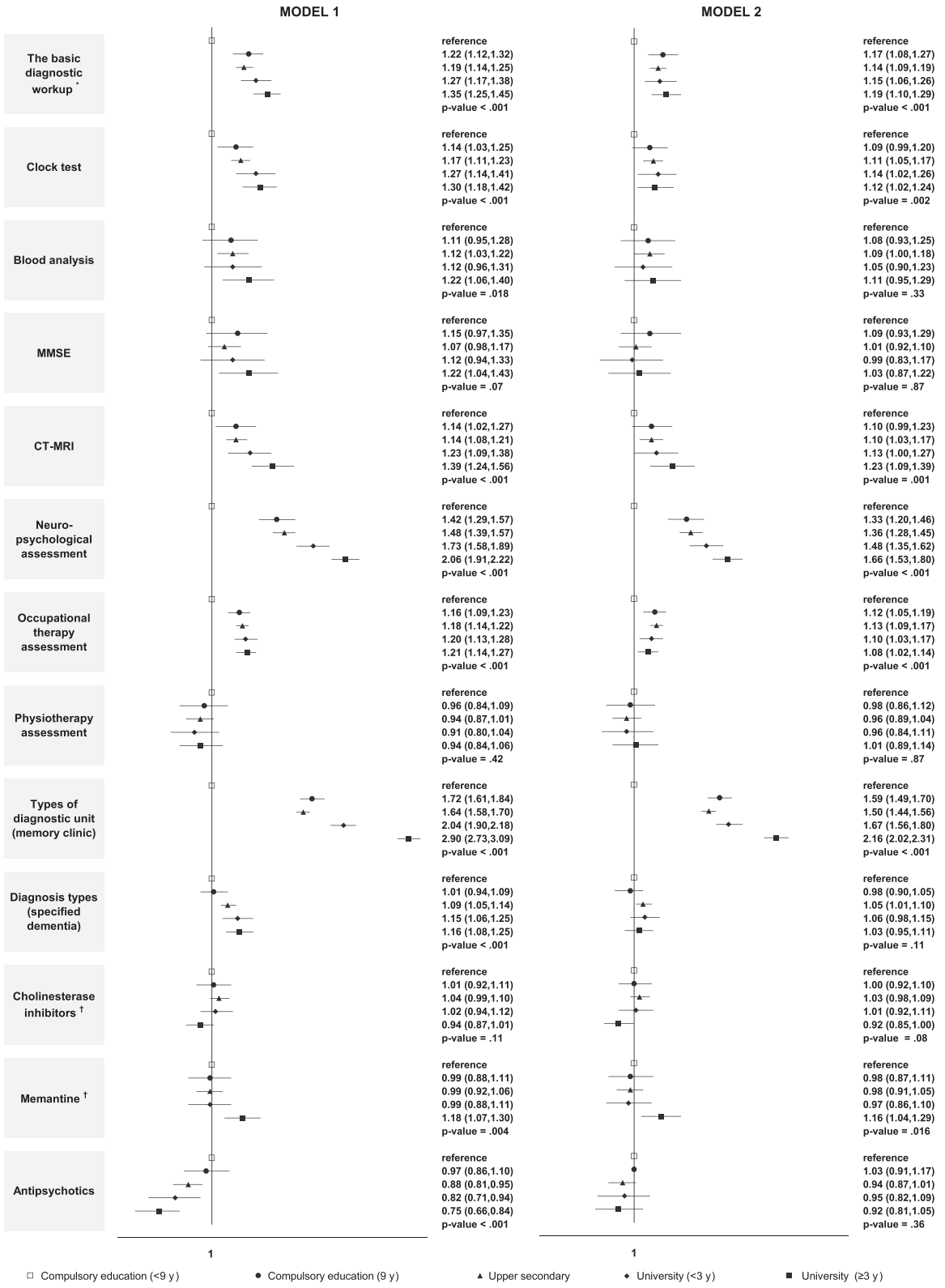

Fig. 1. Dementia diagnosis and treatment in association with education. For all graphs, data were presented as odds ratios (95% confidence interval). Model 1: Binary logistic regression, controlled for age, sex, regions of birth, living alone, dementia types (except for diagnosis types as dependent variable), Charlson Comorbidity Index, types of diagnostic unit (except for types of diagnostic unit as outcome), and MMSE scores (except for basic tests and MMSE as dependent variables). Model 2: Binary logistic regression, controlled for other variables like Model 1 and additionally adjusted for disposable individual income. * The basic diagnostic workup meant whether patients received all basic tests (clock test, blood analysis, MMSE, CT-MRI) or not. † Only patients with Alzheimer's disease or mixed dementia were analyzed (E1 = 13080, E2 = 2687, E3 = 13574, E4 = 2919, E5 = 4335). CT, computed tomography; MRI, magnetic resonance imaging.

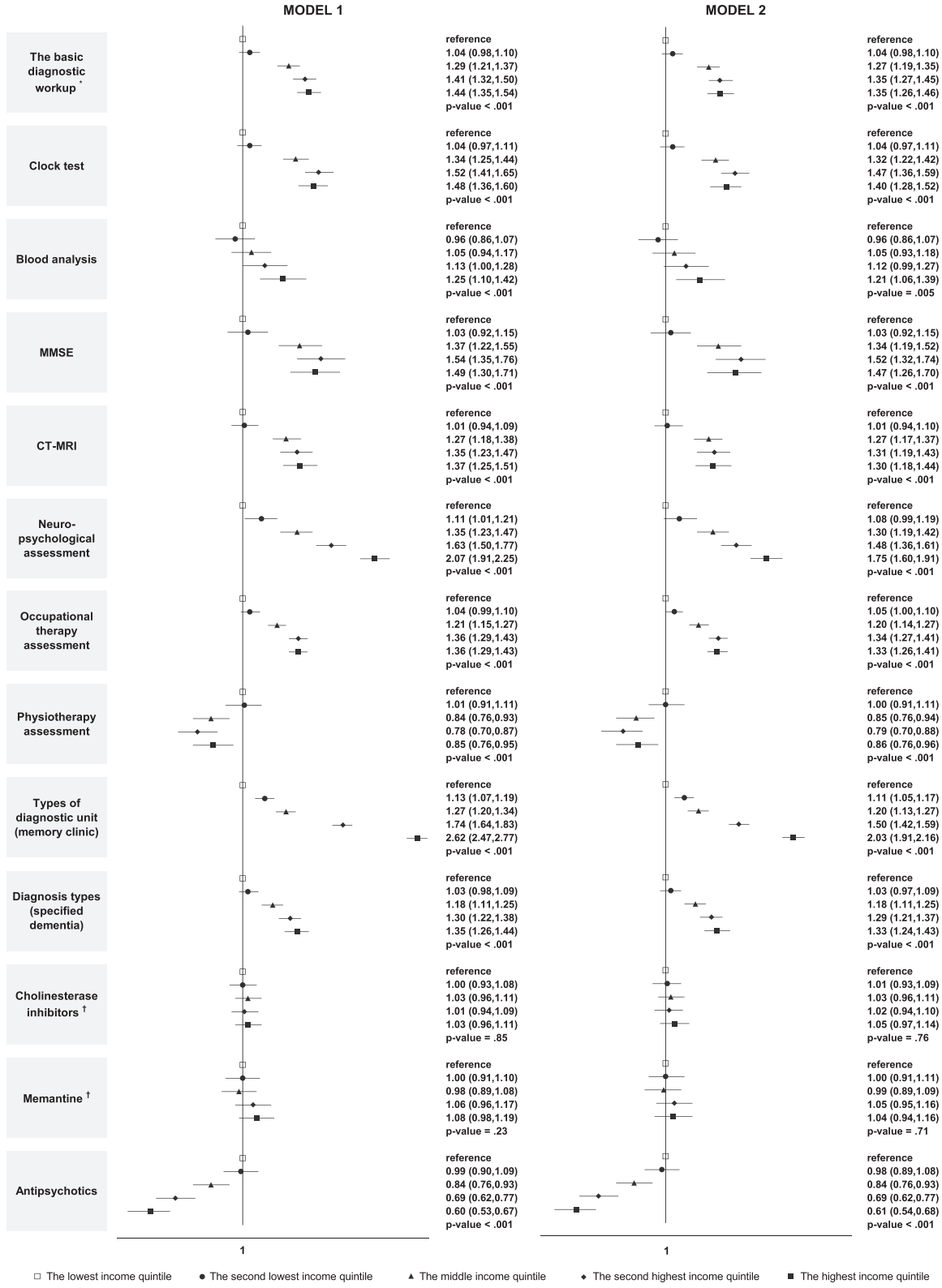

Fig. 2. Dementia diagnosis and treatment in association with disposable individual income. For all graphs, data were presented as odds ratios (95% confidence interval). Model 1: Binary logistic regression, controlled for age, sex, regions of birth, controlled for age, sex, regions of birth, living alone, dementia types (except for diagnosis types as dependent variable), Charlson Comorbidity Index, types of diagnostic unit (except for types of diagnostic unit as outcome) and MMSE scores (except for Basic Tests and MMSE as dependent variables). Model 2: Binary logistic regression, controlled for other variables like Model 1 and additionally adjusted for education. * The basic diagnostic workup meant whether patients received all basic tests (clock test, blood analysis, MMSE, CT-MRI) or not. † Only patients with Alzheimer's disease or mixed dementia were analyzed (I1 = 7138, I2 = 6882, I3 = 7059, I4 = 7696, I5 = 8357). CT, computed tomography; MRI, magnetic resonance imaging.

was double that of PWD in the lowest quintile: (OR 2.03, 95% CI 1.91-2.16). Income was associated significantly with obtaining a specified dementia diagnosis: highest vs lowest quintile (OR 1.33, 95% CI 1.24-1.43). Income was not significantly associated with the prescription of cholinesterase inhibitors or memantine.

Discussion

This study aimed to assess the difference in dementia diagnostic process and antidementia medications in relation to SES. To our knowledge, this is the first study that explored dementia diagnostic process among different SES. We found that PWD with higher income had a higher probability of receiving the basic diagnostic workup, clock test, blood analysis, MMSE, computed tomography and magnetic resonance imaging, neuropsychological assessment, and occupational therapy assessment. Higher educational level was significantly associated with higher likelihood of receiving these dementia examinations, except for blood analysis and MMSE. PWD with higher education or income had higher chances of being diagnosed at a memory clinic. Receiving a specified dementia diagnosis was significantly associated with income (both when adjusting and not adjusting for education), but not with education (when controlling for income). We interpret this to mean that income was more decisive than education, in relation to dementia diagnostic process.

Our study showed that there was no significant association between SES and the use of antidementia drugs, apart from the association between education and prescription of memantine. The result regarding memantine was in concordance with a previous study in Sweden, where PWD with higher educational levels had higher chances of receiving memantine.[13] Unlike ours, other studies found that PWD with higher educational levels had a higher likelihood of receiving cholinesterase inhibitors.[13,27] Differences in age range, time frame, and study population might explain these differences. PWD with higher income were less likely to receive antipsychotics. This finding is particularly important because previous studies have shown that the use of antipsychotics increases the mortality risk in PWD.[28]

Our study is in line with prior publications on the effects of SEP on health care; the difficulty is in identifying why these differences occur and how they can be addressed. From a clinical perspective, our findings may be a signal of unfulfilled care demands and unequal provision of care. This argument is plausible to some extent because unmet health care needs among PWD with low SES in Sweden were reported in previous studies.[14–17] It is possible that PWD with low SES sought or received help later in the disease process (as seen by their higher age and lower MMSE level), which could lead to less extensive testing, and increase the chances of primary care (vs memory clinic) diagnosis. It is less likely that this is the explanation since we controlled both for age and MMSE level. It is important to reconsider the dementia diagnostic process. Assessing PWD's satisfaction with dementia care is also an area of future research. As a group, PWD often receive different care for other somatic conditions than their non-dementia counterparts.[29–32] It is interesting to note that SES further influences care, even within PWD as a group.

From a public health perspective, differences in dementia diagnosis among SES may mean that health care resources were being allocated unequally between PWD with different SES. These differences in the dementia diagnostic process among SES possibly reflected a gap in the quality of dementia care. Meanwhile, PWD with lower SES accounted for a large share of the dementia population and were also more cognitively impaired. Previous studies showed that lower SES was associated with a higher dementia-related mortality risk.[8–11] The Swedish health care system is mainly financed through the regional governments and is universal for residents. Co-pays differ among regions in Sweden, but they are low (maximum $125 per year for health care services). Despite this universal health coverage, income or education lead to differences in the provision of care. In countries without a universal health care system such as the United States, people with lower education or lower income are more likely to forgo medical care due to costs.[33] Another study showed that care disparities due to education and income were more extreme in the United States, compared to Canada, a country with a universal health care system.[34] It appears that universal health care is helpful, but not in itself sufficient, to eliminate SES differences in care. Other determinants of unequal dementia care in Sweden were also shown in previous studies from our group where the type of diagnostic unit (primary vs memory clinic), population density, and living alone affected dementia diagnostic workup.[29,30,35–38] Universal health and social care coverage for dementia are important to ensure the equal access to care services to all PWD.[4] As demonstrated by our study, universal healthcare was not sufficient to eliminate socioeconomic differences in access to care. Socioeconomic inequalities in dementia care should be studied and their impact on patient outcomes should be quantified. In developing nations, an aging population represents a future demographic challenge: considering these issues of access and equality of care early on would help these countries to improve their preparedness for these future changes.

Limitations

There were several limitations in our study. First, we could not investigate ethnic disparities because ethnicity is not recorded in Swedish registers. We tried to overcome this hurdle by using the regions of birth. Second, information about occupation before retirement was not available in our study. Additionally, as in many observational studies, causality cannot be inferred, and we acknowledge the possibility of residual confounding. Typical weaknesses of a register-based study cannot be neglected, such as missing values or incomplete data. Providers of health care in Sweden may be private or public but funding is through the government. We did not consider whether providers of care were public or private because access to care would not differ. Despite drawbacks, the strength of our study is the inclusion of a large national cohort with high quality and coverage for socioeconomic data.

Conclusions and Implications

PWD with lower SES (education or disposable individual income) had significantly lower odds of receiving specific dementia diagnostic examinations, getting a specified dementia diagnosis, and being diagnosed at a memory clinic. There was no significant association between SES and prescription of antidementia medication, aside from the association between education and the use of memantine. Our study results revealed socioeconomic inequalities in the dementia diagnostic process in Sweden. Future studies on health equity and equality of dementia care should be conducted.

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References

1. Institute for health Metrics and evaluation. Sweden. 2019. Available at: http://www.healthdata.org/sweden. Accessed January 30, 2021.
2. World Health Organization. Dementia. 2020. Available at: http://www.who.int/mediacentre/factsheets/fs362/en/. Accessed January 30, 2021.

3. The Swedish Dementia Register. SveDem annual Report 2019. 2021. Available at: https://www.ucr.uu.se/svedem/om-svedem/arsrapporter/svedem-arsrapport-2019/download. Accessed January 30, 2021.
4. World Health Organization. Global action plan on the public health response to dementia 2017 - 2025. 2017. Available at: https://apps.who.int/iris/bitstream/handle/10665/259615/9789241513487-eng.pdf;jsessionid=F5E1224EBBAC6BD499DA6AE960CFC929?sequence=1. Accessed January 30, 2021.
5. Darin-Mattsson A, Fors S, Kåreholt I. Different indicators of socioeconomic status and their relative importance as determinants of health in old age. Int J Equity Health 2017;16:173.
6. Fors S, Thorslund M. Enduring inequality: Educational disparities in health among the oldest old in Sweden 1992-2011. Int J Public Health 2015;60:91–98.
7. Hoffmann R. Socioeconomic inequalities in old-age mortality: A comparison of Denmark and the USA. Soc Sci Med 2011;72:1986–1992.
8. van de Vorst IE, Koek HL, Stein CE, et al. Socioeconomic disparities and mortality after a diagnosis of dementia: Results from a nationwide registry linkage study. Am J Epidemiol 2016;184:219–226.
9. Korhonen K, Einio E, Leinonen T, et al. Midlife socioeconomic position and old-age dementia mortality: A large prospective register-based study from Finland. BMJ Open 2020;10:e033234.
10. Strand BH, Langballe EM, Rosness TA, et al. Age, education and dementia related deaths. The Norwegian Counties Study and the Cohort of Norway. J Neurol Sci 2014;345:75–82.
11. Chen R, Hu Z, Wei L, et al. Socioeconomic status and survival among older adults with dementia and depression. Br J Psychiatry 2014;204:436–440.
12. Chen R, Lang L, Clifford A, et al. Demographic and socio-economic influences on community-based care and caregivers of people with dementia in China. JRSM Cardiovasc Dis 2016;5. 2048004016652314.
13. Johnell K, Weitoft GR, Fastbom J. Education and use of dementia drugs: A register-based study of over 600,000 older people. Dement Geriatr Cogn Disord 2008;25:54–59.
14. Lindstrom C, Rosvall M, Lindstrm M. Socioeconomic status, social capital and self-reported unmet health care needs: A population-based study. Scand J Public Health 2017;45:212–221.
15. Agerholm J, Bruce D, Ponce de Leon A, et al. Socioeconomic differences in healthcare utilization, with and without adjustment for need: An example from Stockholm, Sweden. Scand J Public Health 2013;41:318–325.
16. Molarius A, Simonsson B, Linden-Bostrom M, et al. Social inequalities in self-reported refraining from health care due to financial reasons in Sweden: Health care on equal terms? BMC Health Serv Res 2014;14:605.
17. Wastesson JW, Fors S, Parker MG, et al. Inequalities in health care use among older adults in Sweden 1992-2011: A repeated cross-sectional study of Swedes aged 77 years and older. Scand J Public Health 2014;42:795–803.
18. Religa D, Fereshtehnejad SM, Cermakova P, et al. SveDem, the Swedish Dementia Registry—a tool for improving the quality of diagnostics, treatment and care of dementia patients in clinical practice. PLoS One 2015;10:e0116538.
19. Garcia-Ptacek S, Kåreholt I, Cermakova P, et al. Causes of death according to death certificates in individuals with dementia: A cohort from the Swedish dementia registry. J Am Geriatr Soc 2016;64:e137–e142.
20. Ludvigsson JF, Svedberg P, Olen O, et al. The longitudinal integrated database for health insurance and labour market studies (LISA) and its use in medical research. Eur J Epidemiol 2019;34:423–437.
21. Statistics Sweden. The national patient register. 2021. Available at: https://www.socialstyrelsen.se/en/statistics-and-data/registers/register-information/the-national-patient-register/. Accessed January 30, 2021.
22. Sveriges Riksbank (Swedish Central Bank). Swedish krona (SEK). 2019. Available at: https://www.riksbank.se/en-gb/statistics/search-interest–exchange-rates/annual-average-exchange-rates/?y=2019&m=12&s=Dot&f=y. Accessed May 1, 2021.
23. The Swedish Pensions Agency. The elderly care support. 2021. Available at: https://www.pensionsmyndigheten.se/for-pensionarer/ekonomiskt-stod/ansok-om-aldreforsorjningsstod. Accessed January 30, 2021.
24. Statistics Sweden. Consumer Price Index. 2021. Available at: http://www.scb.se/en/finding-statistics/statistics-by-subject-area/prices-and-consumption/consumer-price-index/consumer-price-index-cpi/. Accessed January 30, 2021.
25. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. J Chronic Dis 1987;40:373–383.
26. The Swedish National Board of Health and Welfare. National guidelines for health and social care of dementia. 2017. Available at: https://www.socialstyrelsen.se/globalassets/sharepoint-dokument/artikelkatalog/nationella-riktlinjer/2017-12-2.pdf. Accessed January 30, 2021.
27. Matthews FE, McKeith I, Bond J, et al. Reaching the population with dementia drugs: What are the challenges? Int J Geriatr Psychiatry 2007;22:627–631.
28. Schwertner E, Secnik J, Garcia-Ptacek S, et al. Antipsychotic treatment associated with increased mortality risk in patients with dementia. A registry-based observational cohort study. J Am Med Dir Assoc 2019;20:323–329.e322.
29. Hoang MT, Kåreholt I, von Euler M, et al. Costs of inpatient rehabilitation for ischemic stroke in patients with dementia: A cohort Swedish register-based study. J Alzheimers Dis 2020;73:967–979.
30. Zupanic E, Kåreholt I, Norrving B, et al. Acute stroke care in dementia: A cohort study from the Swedish dementia and stroke registries. J Alzheimers Dis 2018;66:185–194.
31. Zupanic E, von Euler M, Kåreholt I, et al. Thrombolysis in acute ischemic stroke in patients with dementia: A Swedish registry study. Neurology 2017;89:1860–1868.
32. Subic A, Cermakova P, Norrving B, et al. Management of acute ischaemic stroke in patients with dementia. J Intern Med 2017;281:348–364.
33. Towne SD Jr. Socioeconomic, geospatial, and geopolitical disparities in access to health care in the US 2011-2015. Int J Environ Res Public Health 2017;14:573.
34. Lasser KE, Himmelstein DU, Woolhandler S. Access to care, health status, and health disparities in the United States and Canada: Results of a cross-national population-based survey. Am J Public Health 2006;96:1300–1307.
35. Roheger M, Eriksdotter M, Westling K, et al. Basic diagnostic work-up is more complete in rural than in urban areas for patients with dementia: Results of a Swedish dementia registry study. J Alzheimers Dis 2019;69:455–462.
36. Roheger M, Zupanic E, Kareholt I, et al. Mortality and nursing home placement of dementia patients in rural and urban areas: A cohort study from the Swedish dementia registry. Scand J Caring Sci 2018;32:1308–1313.
37. Garcia-Ptacek S, Modeer IN, Kareholt I, et al. Differences in diagnostic process, treatment and social Support for Alzheimer's dementia between primary and specialist care: Results from the Swedish Dementia Registry. Age Ageing 2017;46:314–319.
38. Cermakova P, Nelson M, Secnik J, et al. Living alone with Alzheimer's disease: Data from SveDem, the Swedish dementia registry. J Alzheimers Dis 2017;58:1265–1272.